# A COST-EFFECTIVE BEER BREWING PROCESS

## Description

The invention concerns an innovative process for brewing beer. The goal of the invention is to disclose a process that reduces considerably the present-day product losses and the resulting serious ecological problems with their associated costs.

Recent publications indicate that the world-wide product losses in beer brewing including processed raw and intermediate materials and final product lie in the region of 20-30%. The main sources of loss occur in the mash production and filtration followed by beer clarification operations after fermentation. Alone in the mashing process losses of up to 20% are caused by incomplete breakdown of the starch and polysaccarides. Up to 10% of the available fermentable sugars from mashing is lost in the mash filtration operation because of inefficient recovery of the fermentable sugars contained in the thick beds of the coarse mashing residues remaining at the end of the filtration operation. Beer losses of the fermented wort of up to 10% are incurred in the average brewery according to the particular type of brewing process, for instance, whether bottom or top fermentation is practiced or whether conditioning substances for clarification after fermentaion are used or not. It is commonly acknowledged that for every litre of beer produced 5-10 litres of biologically highly contaminated effluent are generated.

**The Invention**

**Fig.1** is a flow-sheet of a conventional brewery. The clarification stages **103, 105, 107, 109, 110, 112, 113, 114, 116, 117** causing a large part of the product loss and effluent problem are replaced in the present invention by the stages **202, 204** illustrated in **Fig.2** the apparatus of which complies with the genre of filtration equipment disclosed in **GB2280857.** These are band filters with a filter chamber through which a filter band is intermittently transportable over a support surface that divides the filter chamber into a lower filtrate chamber and an upper turbid liquid chamber, whereby the turbid liquid chamber has a lid-like form and the filter band during the operation when a pressure differential in the filter chamber develops is sealed between the movable dependent edges of the turbid liquid chamber and the filtrate chamber. The advantage of the further developed version of this band filter is that suspensions of finely divided solids can be

filtered fully automatically with the exclusion of air, whereby the residual dissolved products in the thin layers of filtered solids formed are largely recoverable producing a dewatered dischargeable filter cake and a sterile filtrate. With the application of *membraneous* filter bands with particulate cut-off sizes of 0.01-1.0 micron, malt and grain grist for mashing are milled to a mean particle size of 20-100 micron. Such values lead to a much improved yield of fermentable sugars in mashing as well as in washing the spent grist after filtration. According to the invention, the finely divided grist is mashed in a reactor-type of vessel **201**, whereby after heating in stages by means of a heat transfer jacket **213** vacuum is applied by a vacuum generating plant **216** and the agitated contents of the reactor are blown with live steam through a distributor **217**, whereby with comparatively low temperatures and steam consumption undesirable off-taste producing volatiles are removed. from the mash and the precipitation of the hot-break and the breakdown of enzymatic materials as well as sterile conditions are achieved. Subsequently, the agitated contents of the mashing reactor are cooled to precipitate the proteinaceous matter of the cold-break and then filtered by the band filter plant **202.** According to the invention, the finely ground husks and other residual hard materials of the mash are used as filter aid to remove solids and colloids down to 0.01 micron, whereby preferably *membranous* bands with 0.01 micron particle size cut-off are employed. The dewatered filter cake after desweetening is then discharged.

The cooled, filtered, sterile wort is then transferred to the reactor-like fermentation vessels **203** where, according to a further central aspect of the present invention, in order to maintain the wort both before, during and after fermentation free from turbidity caused by the precipitation of protein-like substances, adsorbents such as silica, resins, molecular sieves, etc are added to the wort before and/or during the fermentation process. The purpose of this is to target and remove the maximum quantity of remaining subsequent haze-forming components still in the wort as well as those metabolically produced by the yeast cells during fermentation and thereby, in effect, achieve a stabilized beer direct from the fermenter. According to the invention, to achieve quality reproducibility and efficient removal of haze-forming substances during fermentation a programmed empirical relationship over the period of the batch-wise fermentation between the temperature, pressure and carbon dioxide evolution in the fermenter by means of controllers **223, 220, 218** is maintained. The yeast cells and adsorbent are held protectively by the agitator **222**

in suspension during fermentation and the subsequent filtration. This, according to the invention, promotes the sterility of the apparatus, the quality and yield of the beer, a smoothly running fermentation as well as a considerable reduction in the required cleaning effort of both the fermenter **203** and the filter plant **204** and therefore the effluent problem. The further advantage of the continuous agitation of the fresh yeast cells is their reduction in this state of the off-taste producing diacetyl remaining after the fermentation. Further, in order to conserve the integrity of the fresh yeast cells and therefore the quality of the filtered beer, the agitated contents of the fermenter after chilling are pressured with compressed gas through the 0.01 micron *membranous* band of the filter plant **204**. In this way the filtered, stabilized beer is directly packed at **207** for consumption. A washed, dewatered yeast cake is discharged at **215**.

The considerably reduced quantity of effluent produced during the equipment cleaning and sterilizing operations with the above described innovative brewing process is, according to the invention, treated with a *membranous* filter plant **211** similar to the process filter plants **202, 204.** Solid adsorbents and ion-exchange materials are used to maintain an acceptable soluble organic and inorganic content in the recycled sterile washing and sterilizing liquids. In this way a closed brewery with respect to effluents is achieved by the process of the invention.

## Claims

1. A process for the production of beer, **thereby characterized,** that band filters **202, 204** with a filter chamber through which a filter band is intermittently transportable over a support surface that divides the filter chamber into a lower filtrate chamber and an upper turbid liquid chamber, whereby the turbid liquid chamber has a lid-like form and the filter band during the operation when a pressure differential in the filter chamber develops is sealed between the movable dependent edges of the turbid liquid chamber, are employed for the clarification of the processed liquids, namely wort and beer.

2. A process according to Claim 1, thereby characterized, that mash for filtering to produce wort is made from ground malt and/or grain with a mean particle size of 0-100 micron.

3. A process according to Claim 1, thereby characterized, that to clarify and stabilize the fermented beer the clarified wort is dosed with adsorbents such as silica, resins, etc. before and/or during the fermentation.

4. A process according to Claim 2, thereby characterized, that the mash after heating is subjected to vacuum and blown with live steam while under vacuum.

5. A process according to Claims 2, thereby characterized, that the mash after heating is cooled to produce the cold-break before filtration.

6. A process for the fermentation of beer, thereby characterized, that the fermentation in the fermenter **203** is controlled by a programmed relationship between temperature, pressure and carbon dioxide evolution during the course of the fermentation.

7. A process for the production of beer, thereby characterized, that a band filter or filters **211,** with a filter chamber through which a filter band is intermittently transportable over a support surface that divides the filter chamber into a lower filtrate chamber and an upper turbid liquid chamber, whereby the turbid liquid chamber has a lid-like form and the filter band during the operation when a pressure differential in the filter chamber develops is sealed betwen the movable dependent edges of the turbid liquid chmber and the filtrate chamber, are employed for the purpose of purifying effluents produced in the brewing process.

Fig.1

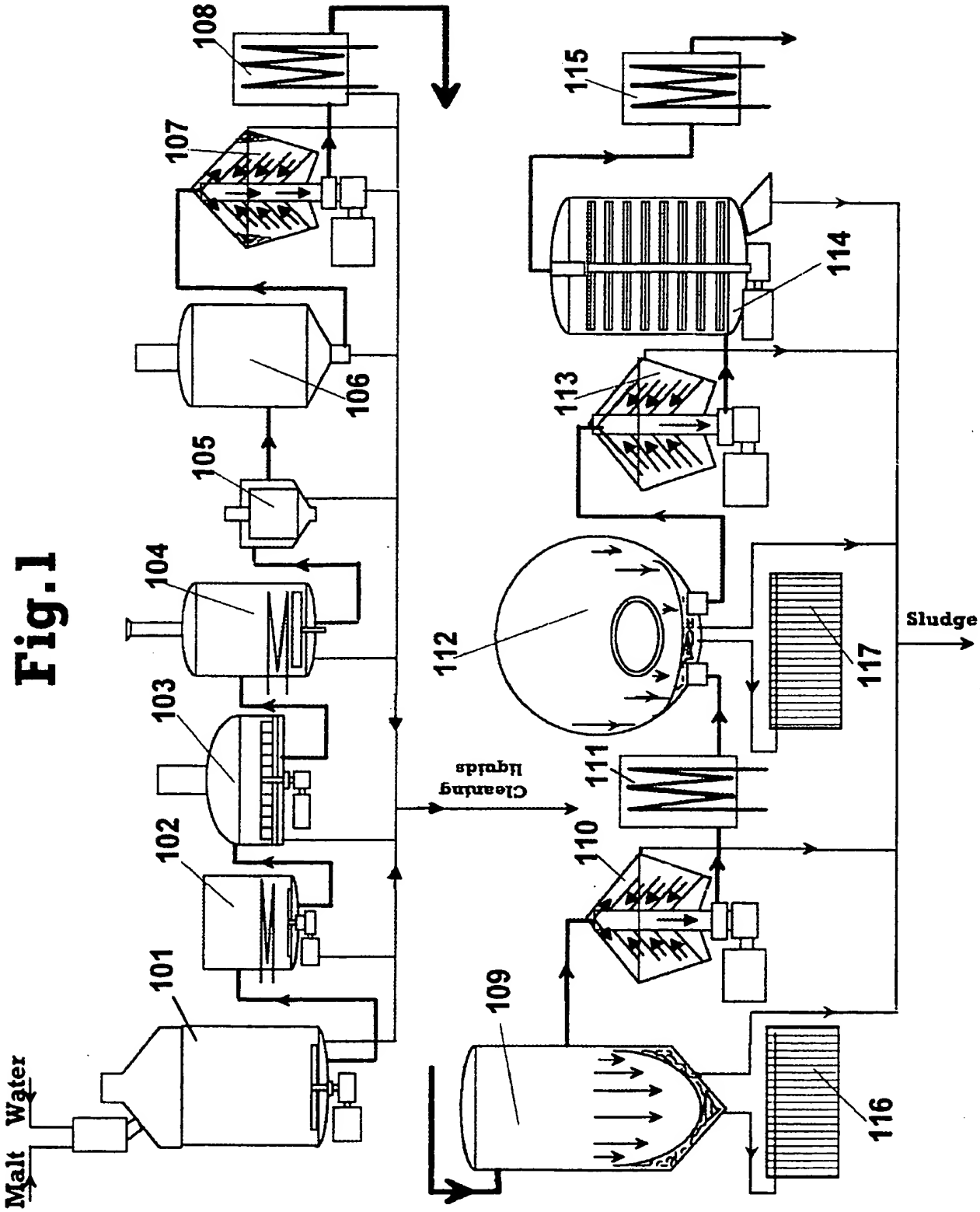
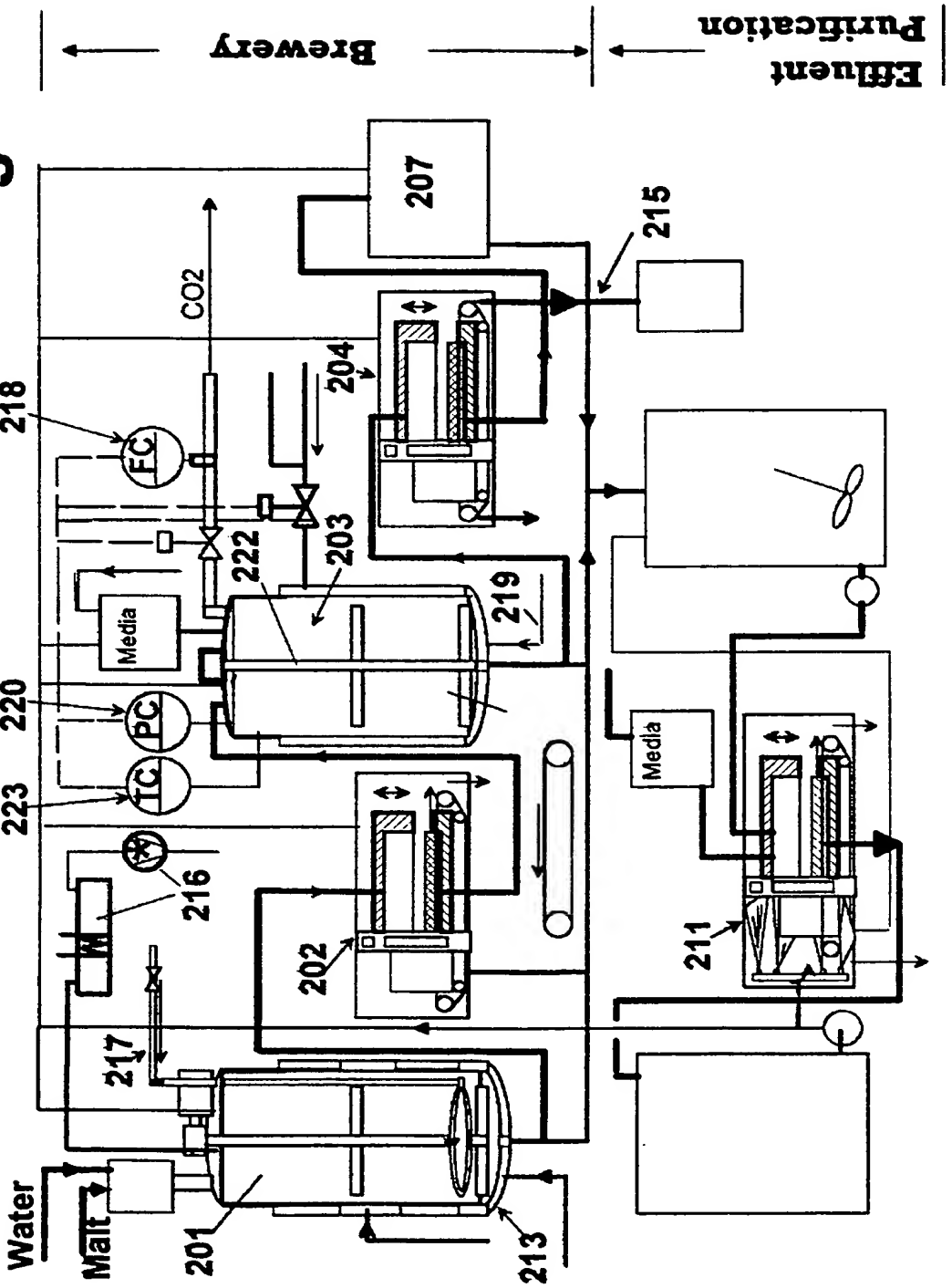

101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
Malt
Water
Clearing liquids
Sludge

Fig.2


Effluent Purification
Brewery
207
215
CO2
204
218
FC
203
222
219
Media
220
PC
223
TC
216
211
202
217
Water
Malt
201
213

# Fig.3

## Key to Fig.1

Conventional beer brewing process

101 mash tun
102 mash kettle
103 lauter tun
104 wort kettle
105 hops strainer
106 wort tank
107 centrifuge
108 cooler
109 fermenter
110 centrifuge
111 cooler
112 conditioner
113 centrifuge
114 filtration (sterile)
115 pasteurization
116 yeast filter
117 tank bottoms filter

## Key to Fig.2

process of the invention

201 mash kettle
202 mash filter
203 fermenter
204 beer filter
207 bottling
211 effluent filter
213 mash kettle heat transfer jacket
215 yeast cake discharge chute
216 vacuum plant
217 steam input
218 $CO_2$ flow controller
219 heating/cooling media nozzle
220 pressure controller
222 fermenter stirrer
223 temperature controller

# INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 98/00199

**A. CLASSIFICATION OF SUBJECT MATTER**

Int Cl[6]: BO1D 29/09, C12C 7/16, 7/24 11/11 C12H1/07

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC: BO1D 29/09, C12C 7/16, 7/24 11/11 C12H1/07

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU IP as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPat B01D 29 or 33 ALE or WORT or MALT
C12C 7 BAND or BELT

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | GB 2280857 A (MILLER) 15 February 1995<br>page 2 last para. | 1-7 |
| X | GB 1571480 A (MOLZAHN) 16 July 1980 | 1-7 |
| X | GB 1388666 A (KERR) 6 Sept.1972 | 1-7 |
| X | US 4310424 A (FREMONT) 12 Jan 1982<br>column 1 | 1-1 |

☐ Further documents are listed in the continuation of Box C

☐ See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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| 15 May 1998 | 21 MAY 1998 |
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